Beyond RCRA:
Prospects for Waste and Materials Management
In the Year 2020

Draft White Paper

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Acknowledgments and Disclaimer

This draft White Paper was drafted by the EPA-State RCRA Vision Workgroup:

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This paper is a work in progress. It is not a statement of EPA or ASTSWMO policy, or of the state agencies or tribes represented on the Workgroup. This paper is intended only to provoke thought and facilitate a public dialogue to explore possible directions for the mid- to long-term future of the RCRA program. The authors expect that this paper will be revised and amended extensively and often, based on future discussions and analyses. The ideas presented in this paper will remain open to honest reflection, and to the ideas of any and all who may wish to offer comments on it. Comments on the draft paper are welcomed, and may be submitted by email to leith.angie@epa.gov.

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"Looking into the future is a fool's occupation, but it is the bigger fool who dares not to."
--Voltaire

A Vision of the Future:

The year is 2020, and America's wasteful ways are a thing of the past. New technologies and a changed economic climate, combined with enlightened government policies and a pronounced shift in societal and corporate attitudes have resulted in dramatic decreases in the volumes and toxicity of industrial wastes generated by the country's industries. Materials that were once considered wastes suitable only for landfilling are now continually reused and recycled, and "industrial ecology" has become the mantra of corporate executives across the nation. The small volumes of wastes that actually need disposal are carefully managed under an efficient and environmentally protective system that features a mix of economic incentives, voluntary measures and regulatory controls. "Mining" of old industrial and municipal landfills has become a profitable business, while cleanup of most contaminated sites has been largely completed, and thousands of areas once known as brownfields have been put back into productive use.

In the meantime, generating and managing post-consumer household wastes has undergone a similar transformation. Concern for environmental sustainability has become ingrained as a societal value, as individuals have become much more aware of the environmental consequences of their consumptive choices. Household recycling appliances, as well as advances in packaging, product design and other measures have reduced household waste generation rates to a small fraction of what they were in the late twentieth century. Far fewer toxic chemicals are now used to manufacture consumer products, and consumers are now far better informed of the potential risks from chemicals in the goods and services that they use.

By the year 2020, a chemically safe environment has also become established legally and culturally as a basic human right. In addition, advancements in telecommunications have created much closer linkages between government agencies, citizens and businesses, and the resulting flows of information have enabled a more participatory approach to making environmental decisions that affect local communities. These developments have in part prompted pollution abatement measures that ensure lower income communities no longer bear disproportionately high risks from exposure to industrial chemical emissions.

These gains in waste and materials management have not, of course, been confined to the United States. Heightened concerns over the health of the global environment, combined with an

increasingly globalized economic system, have created new institutions and policies to promote environmental sustainability and ensure that wastes and materials are managed wisely worldwide.

What kind of world will we actually inhabit in 2020? Some predict that it will be better than the present - where products and materials will be less toxic, reusable, and wastes profitable to reduce. In contrast, others predict that we will experience a bleaker future - where harmful chemicals will be more prevalent throughout our environment and may seriously affect groundwater, drinking water, and food supplies. While we can't know which of these scenarios - or others - will exist in twenty years, it makes sense to consider the future now if we want a chance to positively shape it. This paper is intended to stimulate a dialogue around this important issue.

I. Introduction

At the turn of the new century, the United States has now completed two decades of managing wastes under the federal Resource Conservation and Recovery Act (RCRA). In these past twenty years waste management practices have improved tremendously. Uncontrolled dumping of hazardous industrial wastes has decreased dramatically, and the number of facilities that handle hazardous wastes has shrunk by half. Municipal waste landfills have been upgraded across the country, while unlined hazardous waste landfills and lagoons have almost disappeared from our landscape. Thousands of contaminated sites across the country are being cleaned up to restore land to productive uses and protect ground water resources. Post-consumer recycling rates have risen dramatically, while many industries have made impressive gains in pollution prevention and reducing generation of toxic wastes.

Despite these impressive achievements, the RCRA program has also received its share of criticism, from public interest groups, industry and other stakeholders. This paper, however, is not an attempt to document or analyze the strengths and weaknesses of the RCRA program as we know it today. Rather, after two decades of experience with the current system it is time to look forward to the next 20 years, to begin examining how the program as we know it today could and should evolve to meet the challenges and opportunities of the new century. In 1999, the US EPA, in concert with state environmental agencies, formed a small working group to begin exploring the RCRA program's longer term future. In September, 1999 a roundtable meeting of experts from academia, industry and public interest organizations was convened in Washington, DC to lay the groundwork for this effort. That meeting provided a number of important insights regarding future technological, societal, environmental and economic trends, and how they may affect the future of waste management in this country. The proceedings of the roundtable meeting have been summarized in a separate paper.[1]

[1] Copies of the "RCRA Vision Roundtable Meeting Summary" can be obtained by contacting Dave Fagan of EPA's Office of Solid Waste, at fagan.david@epa.gov.

This White Paper has been prepared for the purpose of creatively engaging and stimulating dialogue on the future of the nation's waste management system, unconstrained by the current legal and institutional structure of the RCRA program. We are not advocating or recommending any particular policies or directions, nor is the paper intended to help advance any particular legislative action. We have also not attempted to quantify how effective any of the measures discussed in the paper might be, nor did we try to calculate their political feasibility.

At this time the paper's primary focus is to suggest the broad outlines of what a future RCRA program might look like, and the forces that might shape it. We have not attempted to suggest any strategy or "next steps" as to how such a future program could be developed, nor have we yet examined the many issues associated with how it might best be implemented. We believe that these issues will best be addressed once the essential elements of this future program have been defined with more clarity and certainty.

The scope of this paper is confined to exploring the future of waste and materials management in the United States, although we believe that much of its substance could be relevant to other nations with relatively affluent, industrial economies. In fact, as noted elsewhere in this paper, it is unrealistic in this era of increasing globalization to consider these issues in purely American terms, and we can certainly learn from other countries' experiences in this area. We acknowledge, however, that the problems we associate with waste and inefficient use of resources in the United States do not necessarily apply in those parts of the world where poverty and resource scarcities often transcend such concerns.

II. Trends and Future Directions

In developing a vision for the future of RCRA (or whatever its successor program may be called), it was necessary to make certain projections and assumptions as to its future "landscape"—that is, the economic, technological and societal setting in which it will operate in the year 2020. These projections and assumptions (summarized below) have been organized into six broad categories: Resources, Health and Risk, Industry, Information, Globalization, and Society and Governance. Readers are invited to consider the validity of these projections and assumptions, and what effect other, different assumptions may have on the future of waste and materials management as discussed in this paper.

Resources

— **Pressures on natural resources will continue to increase.** We believe it is relatively safe to assume that worldwide demand for basic resources (e.g., fresh water, minerals, energy sources, fibers, etc.) will continue to increase over the next twenty years, as the world's population increases and the global economy continues to expand. It is also likely that a number of areas of the world that now have relatively low living standards will become more prosperous, which will also tend to increase demand for goods and services and the basic resources that are

used to supply them. It is not assumed that there will be wide-scale shortages of basic resources or commodities in the year 2020. However, it is expected that as worldwide demand for resources mounts, it is possible that some specific resources may become less abundant and/or more difficult to exploit in the future, which could increase their economic value. Some of these variations in supplies and costs of commodities/materials will likely vary geographically. Increased costs of some commodities would likely result in some changes in consumptive behavior, but should also create market pressures to develop substitute materials and/or products.

— **New technologies will change how resources are used and wasted.** Technological advancements will also affect the availability of resources and the way we use them. It is entirely possible, for instance, that a dramatic technological breakthrough could alter in a positive way the current balance between resource supplies and demands, and the efficiency with which they are used. For example, a revolutionary new energy source could realize extraordinary environmental, economic and social benefits by substantially reducing the use of fossil fuels. It seems at the point unwise, however, to assume that technological advances will somehow rescue us from having to worry about these issues in the future. It is more likely that the effects of technological change on economic and ecological sustainability over the next few decades will be more mixed, though nevertheless profound.

This mixed prognosis could certainly be true not only as to how resources will be extracted and used in the future, but also how they will be wasted. For example, new technologies could enable extractive industries (e.g., minerals, petroleum, etc.) to become more efficient, and thus less wasteful. This is already being seen in a number of manufacturing industries, with the prospect of important future advances in energy efficiency, efficient use of materials, and materials substitution. Life spans of some products will likely increase, which could decrease waste volumes. On the other hand, technological innovations could create demands on different types of resources, or could produce new consumer products that are popular but resource intensive. The sheer rate of technological change could also result in many products that quickly become obsolete, which could also increase waste generation rates.

— **Need for more sustainable use of resources.** The general conclusion is that the current trend is toward greater demands on and consumption of material resources, in this country and elsewhere. While the economic value of some of these resources may increase, the more important (but often hidden) price to be paid may well be an environmental one. Extracting, producing and using ever-increasing volumes of material resources–most of which are finite--will inevitably have important environmental consequences. Some recent studies have projected that the current global economy cannot be sustained over the long term without

severe environmental consequences. The challenge at hand is therefore to create a system that enables economic prosperity to co-exist with a healthy global environment, by making more efficient use of the material resources that we consume.

Health and Risk

— **More chemicals and new risks.** The numbers and amounts of man-made chemicals that are produced, used and eventually disposed of have dramatically increased over the past several decades. This trend is expected to continue, and it is likely that by the year 2020 advances in chemistry, biology and other fields will have created tens of thousands of new chemical compounds, many of which will be derived from genetically engineered organisms. Undoubtedly, some of these new substances will have the potential for causing harm to human health and ecological systems.

— **Health effects of chemicals will be better understood.** It is expected that scientific advances over the next few decades will yield a much deeper understanding of how various chemicals affect human and other living organisms. It is likely we will learn that some chemicals are more harmful than we now think, while others may be found to be less harmful than is now understood. We will also likely better understand the health effects of chemicals among subpopulations, such as children and the elderly, people with genetically predisposed chemical sensitivities, and people who have had chronic or multiple exposures to chemicals. In addition, much more should be understood as to cumulative and synergistic risks to people who may be exposed to multiple chemicals over time because of where they live or work. As this information becomes available, communities with particularly high risk burdens will expect government and industry to take action to reduce those risks.

— **Methods for measuring and managing chemical risks will improve.** Techniques for estimating the fate and transport of chemicals in the environment should advance greatly in the next few decades, with corresponding advances in technologies used to detect and analyze (and perhaps characterize the risks of) chemicals in the environment. Life-cycle risks of chemicals as they are produced, used/reused and disposed of will be better understood, and it is likely that more examples will be identified of potentially harmful chemicals in common consumer goods and services (recent examples would include lead in gasoline, and mercury in home thermometers). As the public becomes more aware of these risks, it is possible that they will demand more comprehensive and proactive measures from industry and government to mitigate them.

Industry

— **Industry will consume and waste different types of materials.** Over the next twenty to thirty years a wide range of new products and materials will be produced by the US economy, which will have important effects on the profile of manufacturing residuals (wastes, by-products, etc.) that are generated by industry. For instance, there are already many examples of products and industries in which potentially harmful chemicals have been phased out in favor of more benign materials. This trend, which we expect will continue, will have many positive environmental effects, including generation of wastes with lower hazard potential. On the other hand, production of some new chemicals and products may generate new, relatively high-risk waste streams. As some existing industries evolve over time, the volumes and characteristics of the wastes they generate can also be expected to change, for better or for worse. The geographic distribution of waste generating facilities in this country can also be expected to change in response to a number of different factors.

— **Industry will be more efficient and less wasteful.** Given the assumption that the economic value of certain basic materials and resources may broadly increase over the next few decades (as discussed above), it seems safe to assume that market forces will create greater incentives to use such materials more efficiently. This may be manifested in products that contain less expensive substitute materials, or that use less material per unit of production. More valuable materials will also create new incentives to reuse or recycle many products, as well as many wastes and by-products from various manufacturing processes. Technologies for reuse and recycling of materials should also advance in many areas, which could lower the rate at which many such materials are wasted.

  As a general matter, therefore, the capabilities and incentives for American industry to use material resources more efficiently (i.e., less wastefully) will likely increase over time. Many materials that are now considered wastes will instead be used to produce new materials and products. As this happens it is likely that current distinctions between wastes and materials (which are in large part regulatory in nature) will become less meaningful. This could argue for government policies that more effectively promote, and reduce unnecessary regulatory constraints on, more efficient use of these materials.

— **Wastes will still be with us.** Wastes will not disappear by the year 2020. Though industry may well become much less wasteful in producing the goods and services that the domestic (and global) economy will demand over the next few decades, it seems logical to assume that some industrial residuals will continue to have very low potential for productive reuse or recycling, and will thus need to be managed as wastes in much the same manner as they are now. We must anticipate, therefore, a continuing need to ensure they are managed safely under

some system of controls and/or incentives that is at least analogous to today's hazardous waste regulatory framework.

Given that wastes (and the need to manage them safely) will exist in the future, we can anticipate that waste treatment and disposal technologies will evolve in important ways. Such future technologies could include the use of chemical markers, sensing and monitoring devices, and/or advanced telecommunications systems to more closely track generation, composition, movement and ultimate disposition of wastes by industry, government or perhaps even interested citizens. Waste treatment technologies should also improve, as should the performance of landfills and other disposal techniques. It may be that the concept of disposal as we now know it (i.e., permanent entombment) will also change over time if, for example, new technologies or economic forces emerge that enable recovery of materials from previously landfilled wastes.

Information

— **The information revolution will continue**. Over the next few decades we will almost certainly continue to see dramatic increases in the amounts of information available to nearly everyone on the planet, and their ability to access and share it. At this point it hardly seems possible to overestimate the effects that this will have on virtually every aspect of today's society and economy.

— **Industry, individuals and the environment will benefit.** Advances in information and communications technologies have already begun to transform the way business in general is conducted in this country, and many of these advancements should be environmentally beneficial with respect to waste and materials management. For instance, more efficient information exchange should stimulate the business of buying and trading recyclable materials between companies and industry sectors, which could create much more sophisticated markets for such materials, similar to the commodity markets of today. Similarly, more information should enhance the ability of individual consumers to make more environmentally friendly choices for products and services. As a general matter, we believe that in the year 2020 faster and more efficient information flows will result in greater awareness and knowledge of environmental issues and concerns on the part of individuals, businesses and other institutions.

Globalization

— **The global economy will be more highly integrated.** The trend toward an increasingly globalized economic system is also likely to have important effects on the future of waste and materials management. Freer movement of money and materials may result, as many now predict, in a much more integrated world economic system, as well as higher levels of prosperity and consumption in many

countries. Increased global demand for material goods and services would create the need for more capacity in manufacturing and extractive industries, which are likely to become more globally dispersed. The environmental impacts of these industrial activities worldwide would presumably also increase, though this could potentially have both positive and negative environmental consequences for the United States and other parts of the world.

— **Environmental protections will need to be more internationalized.** The worldwide environmental consequences of freer trade and international monetary policies have recently become the focus of a highly visible public debate, particularly in the United States and Europe. This debate may go on for many years. In any case, this issue may be particularly relevant to environmental concerns regarding waste and materials management, in part because such materials can be easily moved between those countries that have strict environmental protections and those that do not. Therefore, if new approaches to waste and materials management in the United States are to be successful they will likely need to be harmonized with, if not integrated into, a more global system for instituting and maintaining environmental protections.

Society and Government

— **Citizens will have more influence in environmental decisions**. Recent years have seen important changes in the relationships between citizens, industry and government regarding waste management issues, particularly at the local level. Much of this has been driven by increased awareness and environmental activism on the part of individuals and grassroots community groups–as people become more aware of chemical risks, they naturally demand further protections. By the year 2020 it is expected that continued developments in information and telecommunications technologies (as discussed above) will have created much stronger linkages than exist today between citizens and the government institutions that serve them. One result of this trend may be that citizens will be empowered to more directly and effectively influence government decisions on environmental issues that are local, regional or even global in nature.

One result of greater citizen involvement in environmental decisions would hopefully be to focus increased attention and resources on environmental problems that to date have not been adequately addressed by government or industry. One example might be a concerted effort to upgrade waste management practices on Native American lands and remote settlements in Alaska, where the environmental realities of waste disposal are still often harsh. Another could be actions to further reduce exposure to harmful chemicals in communities that bear disproportionate risks from nearby sources of pollutants.

The environmental justice movement has framed environmental protection, including patterns of impacts, as a civil rights issue. Others have framed environmental health more broadly as a human rights issue. We believe these efforts will continue and that the right to live in a relatively clean environment will continue to gain currency in this country as a basic civil right and a human right, through both laws and societal attitudes.

III. Goals

As originally conceived, RCRA was designed primarily as a system of controls over management of wastes in this country, with two fundamental mandates: protection of human health and the environment from waste management and mismanagement, and resource conservation. To achieve these mandates, EPA and the States (and to a lesser extent, tribes) were provided with two primary tools: broad authority to regulate management of wastes, and broad authority to enforce its regulatory and statutory provisions. The statute, however, limited the scope of the regulatory program to certain types of wastes and certain types of regulatory mechanisms (e.g., permits, land disposal restrictions). RCRA was also designed to fit within the existing framework of media-specific environmental laws (Clean Water Act, Clean Air Act, etc.). Thus, Congress by design limited the scope of the program and its goals, and provided EPA and the States with a set of specific tools for implementing the program.

We believe that the original broad mandates of RCRA remain valid, and will be valid in the year 2020. However, we now have two decades of experience with federal, state and tribal regulation of waste management in this country, and perhaps more importantly, we can see that the "landscape" of waste management will change dramatically over the next twenty years. It therefore makes sense at this time to examine how waste and materials management should evolve in this country to meet future challenges and opportunities, while building on the elements of the current RCRA program that have been most successful. In doing so we believe it is necessary to redefine the specific goals that will guide such a future program, and examine new tools and strategies to achieve those goals.

The following discussion describes three goals that we believe could form the foundation of a new system for waste and materials management in the year 2020. For each goal we also suggest some tools and strategies that might be effective in making such a new system work. Ultimately, of course, decisions as to the specific shape and scope of a future system, and its legal underpinnings, will likely need to be made through the legislative process.

Goal #1: Reduce waste and increase the efficient and sustainable use of resources.

As discussed previously, over the next few decades it is likely that the human population of the planet will continue to rise, as will the material aspirations of large numbers of people in many parts of the world. Many believe that the resulting increased demand for resources cannot

be sustained without wide-scale degradation of the global environment, unless those resources are used with much greater efficiency than they are today. It should be understood that the concept of sustainability addresses many different issues, such as land use and species protection issues, which may only indirectly relate to waste or materials management. This goal would address the issue of sustainability only as it relates to material resources that potentially may be discarded as wastes.

Since resources are wasted in many different ways, meeting this goal would require pursuing several different objectives, and measuring success in different ways. One objective would be to reduce the overall volumes of wastes that need to be disposed of in this country, regardless of source or composition. Some would argue, in fact, that "zero waste" should be the goal. Though such a goal is almost certainly not realistic for the economy as a whole, it has the virtue of clarity and simplicity, and some companies have already adopted it as a corporate philosophy, with impressive results.

Of particular importance in working toward this goal would be to reduce generation/ disposal of industrial wastes in particular; i.e., from extractive, manufacturing, service, and other industry sectors. Reducing the amounts of materials used to make certain products, or to perform certain services, would be another objective. Increasing the useful life of products would also contribute to this goal, as would increased rates of reuse/recycling of materials and products.

Meeting this goal would probably also require fundamental changes in the waste vs. non-waste regulatory construct that is embedded in the current RCRA system. The preferred result, for instance, would be that what are now considered wastes would be treated more as material commodities with potential uses, rather than as useless materials destined for disposal. One approach to making such a system work would be to identify materials as "wastes" only when they are clearly destined for disposal; until then, all potentially hazardous materials would be subject to the same set of management controls/incentives.

An integrated waste/materials management system would need to address potentially hazardous materials and products that are clearly not wastes, and which currently are subject to regulation under the Toxic Substances Control Act (TSCA). Thus, making such a system work would require integrating the functions of what are now two separate and distinct, congressionally mandated programs. A new, broader system of incentives, controls, and functions would likely need to assume a new legal and programmatic identity, rather than being grafted onto either RCRA or TSCA. Such consolidation (which might not necessarily be limited to RCRA and TSCA) could also have the advantage of greater consistency and administrative efficiency for both industry and government.

Since one of the main objectives of this type of system would be to encourage more reuse and recycling, an important concern would be to ensure that the resulting materials and products are safe, and do not contain unacceptable amounts of potentially harmful substances (i.e., "toxics along for the ride"). This has been and remains one of the most difficult challenges of the current RCRA program; making it work more effectively in a future materials management system

would likely require development of more sophisticated risk assessment techniques than are currently available, and/or establishing contaminant limits on a product-by-product, or industry-by-industry basis.

Tools and Strategies:

— **Economic tools may be most effective.** In a market economy, decisions involving which resources are used, what they are used for, how efficiently they are used, and ultimately how they become wasted, are primarily driven by economic forces. Thus, the most effective tools for achieving this goal are likely to be those which use economic incentives to promote more efficient resource use, and thus minimize waste generation. Specific tools could include waste generation fees or surcharges on consumption of certain resources, or credits or rebates to reward resource use efficiencies. With many of these tools, revenues could be generated and invested in specific ways to help achieve this goal, such as developing more efficient recycling technologies and/or developing markets for recycled products or materials. Achieving this goal might also include measures to reduce current economic incentives that tend to encourage the use of virgin raw materials.

— **Informational and technical innovations may also be effective.** Informational tools, such as investments in public education to enhance awareness of resource use/sustainability issues, could be an important part of meeting this goal. This could involve labeling of consumer products (e.g., some type of sustainability rating), media-based public service campaigns, internet resources, and others. In addition, more resource-efficient technologies could be stimulated by government policies; these might be developed through NASA-style direct investments in hardware, or other targeted, government-funded research and development initiatives.

— **Need for new regulatory strategies.** Many traditional environmental regulatory mechanisms (e.g., pollutant emission limits) would likely be less effective than other tools in helping to meet this goal, since such controls would only marginally affect the economics of resource use/reuse. Regulatory mechanisms that could more directly affect resource use/reuse would likely be necessary. One such approach might be a system of "extended product responsibility," under which proper stewardship of products at the end of their life-cycles would be the responsibility of the manufacturers, retailers, local governments, and/or other appropriate entities, analogous to the producer responsibility programs already in place in several European countries. Other regulatory approaches could include prohibitions on disposal or mandated recycling of certain types of post-consumer and/or industrial wastes. In addition, quasi-regulatory approaches that might be effective could include greater reliance on corporate environmental management systems (e.g., ISO 14000), third-party certification systems, use of industry-

specific standard practices or methods, local government or community-based oversight, or other approaches.

Goal #2: Prevent harmful exposures to humans and ecosystems from the use of hazardous chemicals.

Exposures to potentially harmful chemicals can occur from the products and materials that we use in everyday life, as well as from exposure to wastes. If distinctions between wastes and materials become less important in the future (as suggested by Goal #1), the need to comprehensively control risks from hazardous chemicals and materials throughout their life-cycles would become a critical feature of the future program. A truly comprehensive program would thus need to appropriately address risks from chemicals as they are produced, transported and used in product manufacture, as those products are used and reused, and when the chemicals ultimately become wastes with unwanted harmful properties. Harmful chemicals (such as dioxins) that do not have commercial uses but which are nevertheless present in the environment and pose potentially serious health or ecological risks could also be addressed under such a broadened waste/materials management system. As discussed below, a regulatory program similar to the current RCRA Subtitle C system would almost certainly be unworkable for the purpose of a more comprehensive materials management system.

At the present time, managing risks from potentially harmful chemicals in the United States is accomplished through a patchwork of federal, state and local regulatory controls, voluntary industry standards, liability incentives, public education efforts, and emergency response services. In many respects this current system works reasonably well. There are, however, inherent gaps and inconsistencies as to which chemicals and which types of exposures are addressed, under what circumstances, and what types of risk mitigation measures are employed. We believe that a more coherent and consistent system for managing chemical risks could benefit human and environmental health, and could be advantageous to industry in many ways as well.

Tools and Strategies:

— **More information could be a powerful tool.** Informational tools (perhaps combined with other tools) might be the most effective way to reduce risks from chemicals in consumer products and other commonly used materials. More information on potential risks could influence the consumptive choices and behaviors of individuals, which could create powerful market incentives to make lower-risk products, in much the same way that nutritional labels on food packaging have greatly enhanced our ability to make informed dietary choices.

— **Potential for economic incentives and technical innovations.** Economic incentives and/or disincentives might be effective in furthering this goal, by (for example) making it more costly for manufacturers to use certain high-risk

chemicals, or encouraging development and use of less harmful materials. Liability schemes are another type of tool that could provide strong incentives for industry to manage chemicals safely, as could certain types of insurance instruments. Chemical use risks could also be mitigated by technological advances, such as through development of less harmful substitute chemicals or improved chemical handling techniques and equipment.

— **Some regulatory controls would be needed.** Some traditional environmental regulatory controls would almost certainly be necessary to ensure safe products and safe handling of hazardous chemicals by industry. Such controls might address siting of facilities, transportation and storage of hazardous materials, limits on hazardous chemical content of certain products, or outright bans on very high-risk chemicals. We believe, however, that any such system of regulatory controls would need to be less complex and more performance-based than the current hazardous waste regulatory system.

Goal #3: Manage wastes and clean up chemical releases in a safe, environmentally sound manner

A fully realized transition from a RCRA-style waste management program to a broader materials management system has the potential for substantially reducing the volumes of wastes that are generated by the nation's businesses and households. However, as discussed previously, it is almost certain that two to three decades from now wastes will still be with us. Ideally, of course, all wastes would be used and reused in a continuous cycle, in much the same way as natural ecological systems work. Unfortunately, American industry is not as efficient as nature at materials recycling, and is unlikely to become so within the next few decades. Although the types, volumes, and composition of wastes will change over the next few decades, we must assume a continued need for waste disposal capacity, as well as some type of management system that ensures adequate protections for human and ecological health.

In fashioning an effective waste management program as part of a broader materials management system, one of the important issues that would need to be addressed is how and at what point in a material's life cycle it would be considered a waste. As discussed above, one approach could be to classify a material as a waste at the point where it is clearly destined for disposal, such as when it is shipped to a facility to be landfilled. Since under an integrated materials management system all materials would be subject to essentially the same controls/incentives, the concept of waste management would be reduced (from the current RCRA program) to controls over transportation, landfill design, operation and monitoring, and any required treatment of wastes prior to disposal in landfills.

Under this type of system the current "cradle-to-grave" approach to waste management would be supplanted by a system in which materials that are now considered wastes would instead be presumed to be valuable materials, unless and until their useful life is expended

(however that may be determined). This type of system could therefore be thought of as a "retirement to grave" waste management system. The main features of a future waste management system, particularly for high-risk industrial wastes, would likely evolve from the more successful elements of the current RCRA program.

A major emphasis of the current RCRA program involves protection of ground water and other environmental media from contamination, by both prevention measures (e.g., unit design standards and monitoring requirements) and cleanup of past releases. Preventing future releases would obviously remain a key objective of a future waste management program. By the year 2020 cleanup of existing contamination problems at RCRA-regulated facilities will hopefully be largely complete, though some long-term remediation work may still be ongoing, and some mechanism for addressing future releases will presumably be needed. This cleanup function of the current RCRA program could be retained in a future waste management system, or could become the responsibility of one or more other federal or state cleanup programs.

Tools and Strategies:

— **Some regulatory controls would likely be necessary.** Under a more comprehensive waste and materials management system, the materials that would be considered wastes would primarily be those that are lowest in value and least amenable to reuse/recycling. Because these "wastes" would have negative value to those who generate them, there would be a clear incentive to dispose of them as inexpensively as possible. This at least implies the need for a system of government-administered controls, particularly for those wastes with the highest relative risk potential. As stated previously, a future regulatory system should be able to effectively protect public health and prevent mismanagement of waste materials, while being less complex and more performance-based than the current RCRA Subtitle C system.

— **Other tools could lessen the need for regulation.** Economic incentives such as surcharges on waste generation or disposal might be used to further encourage waste minimization. Revenues from these incentives could be used to develop waste treatment and recycling technologies. Other fiscal policies, such as tax credits for companies that reduce waste generation, or a requirement that companies maintain certain types of insurance, could also be effective incentives.

Information tools could also work. For example, public disclosure (e.g., on the internet) of facilities' waste generation and management practices could create pressure on companies to manage wastes safely. Advanced information and communications tools could also enhance government and third-party oversight capabilities over waste management activities.

It is also entirely possible that future technologies could make waste treatment much more effective and/or less expensive than today. In the next twenty years

we will also presumably have much more information on the long-term performance of landfill containment systems, which could lead to significant improvements in waste disposal techniques.

IV. Conclusions

The only certainty about waste and materials management in the year 2020 is that things will have changed considerably from today, no doubt in many ways that are impossible to anticipate at this time. We believe that the current system for waste management in the United States, and perhaps other environmental regulatory programs that were developed in the 1970s, will also need to change in important ways if we are to meet the environmental challenges of the coming decades.

We acknowledge the likelihood that some of the trends and directions articulated in this paper will ultimately be proved wrong, and that the future of waste and materials management two decades from now will be influenced by many forces which we have not anticipated. This does not argue for inaction, however. In fact, we believe that the fundamental goals of a future waste and materials management system, as described in the preceding section of this paper, will likely remain valid twenty years from now, despite these uncertainties.

We believe that sustainability is a critical environmental, economic and quality of life issue that this country and others will need to confront over the next decades. Since the United States is by far the world's largest consumer of goods and services, we have the responsibility to act with serious purpose to use resources more efficiently and work toward a more sustainable national and global economy. We believe that developing new approaches for conserving resources, reducing toxic materials and managing wastes properly can and should be an important part of responding to this challenge of making a more sustainable world. Promoting resource conservation along with economic growth will need the full range of innovative tools we can collectively devise.

Potentially harmful chemicals can enter the environment throughout the materials life cycle: from material extraction or creation; product manufacturing; commercial or personal use; and ultimately, as they are disposed of as wastes (at this point in time, waste disposal probably represents only a small part of the source of exposure to harmful chemicals). If we want to reduce the volume of materials used in creating a sustainable lifestyle and reduce the amount of toxic chemicals in the environment, we believe that we need as a society to focus on materials management as well as proper waste disposal. How to create the proper set of economic incentives, share accurate information to inform choices, control and restrict improper practices, and measure the environmental benefits of such a system will be the major challenges facing those who may be interested in pursuing the goals outlined in this paper.

Many of the ideas presented in this paper suggest the need to create a more comprehensive system for waste and materials management, in ways that go well beyond the

scope of the current RCRA program. For example, controlling risks of chemicals throughout their life cycles (i.e., before and after they become wastes) under a single, unified system would obviously be a major departure from how the RCRA and TSCA programs currently operate. It might also require integrating other programs and authorities, including some that are not currently administered by EPA. We recognize that creating such a comprehensive or "holistic" system for wastes and materials would be a complex undertaking. We are certain, though, that these are ideas well worth exploring. It may be that this could eventually become part of an even larger effort to create a single, unified program for all environmental media that the federal government, the states and tribes now implement under various statutes.

While seeds for this broader effort may be nested within the ideas contained in this paper, we encourage the reader to join the dialogue surrounding the primary task the authors of this paper have set for themselves: how can appropriate policies regarding resource conservation, materials management, and the proper disposal of wastes (which will hopefully be smaller in volume and less potentially harmful) emerge to meet the challenges of the next quarter century?